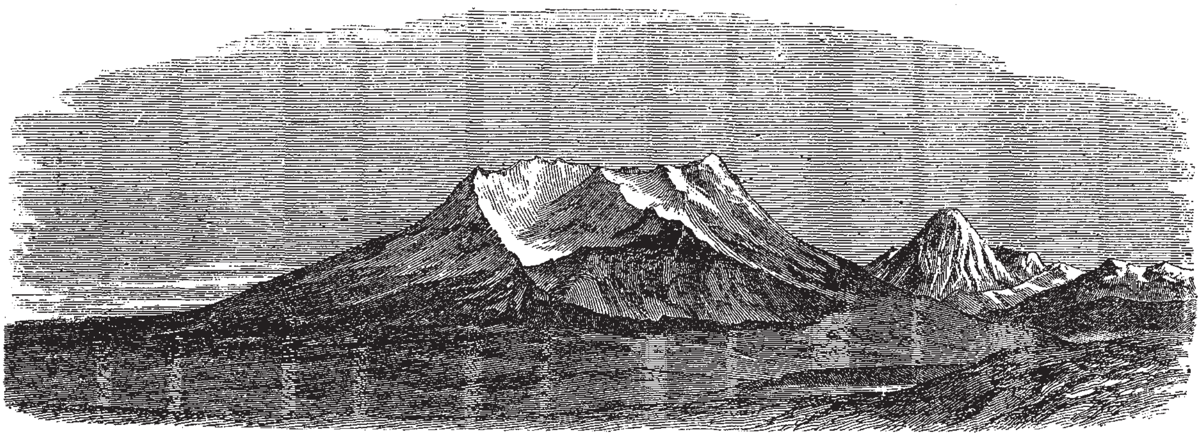
which is situated in the interior of the North Island, had burst into active eruption in the month of April last, and for the first time within the knowledge of the colonists, or even the traditions of the Maories, lava streams have been emitted. On the occasion of previous eruptions, the outbursts have consisted only of ashes and gaseous matters, the former having been spread over a district extending for upwards of thirty miles round the mountain. The volcano is 6,000 feet high, and consists of a group of irregular broken cones, and one very perfect cone, known to the natives as Ngauruhoe. Jets of boiling water and steam continually issue from the north side of the mountain. At an altitude of 3,600 feet, and on the top of Tongariro proper, is a lake 300 yards across, the water of which is of an intense green colour. Ten miles to the south of Tongariro is the ancient trachyte cone of Ruapehu, which is the loftiest mountain in the North Island, having an altitude of 9,600 feet. It is a notable circumstance, that on the 5th of April last, when electrical disturbances were so marked in Europe, and the brilliant displays of Aurora Borealis were generally observed, the corresponding phenomena of the Aurora Australis were extremely well marked in the Southern Hemisphere, attended also by electrical disturbances of unusual character; and on the same evening a well-marked earthquake shock was experienced in the volcanic district of New Zealand, and shortly after the above eruption was reported. The country is very inaccessible at this season, but from the north end of Taupo Lake, where there is now a telegraph station, a distant view is obtained. On the 10th July, the immense volumes of dense black smoke which are being emitted from Tongariro were plainly visible from the hills at Napier, as well as from parts of the surrounding plains. Loud reports were distinctly heard for the previous fortnight, like the boom of heavy artillery, or rather the noise caused by the falling of an immense body of matter, at intervals of five minutes or thereabout. These reports (which are very loud in the vicinity) are sometimes accompanied by a quiver of the earth, and in each case by a great up-burst of flame and red-hot masses like molten rock. A broad stream of red-hot lava is distinctly visible flowing down the side of the mountain in a wavy irregular mass; and in the night the flames issuing from the crater are described as forming a highly interesting and beautiful spectacle.

On the 18th a surveyor reports that he observed, about 1.15 P.M., a sudden column of smoke come out of Tongariro (just as if a steamer was firing up), and soon after it seemed to change to white steam; he stood on a hill about eighty miles distant, and could just see the top of Tongariro to the east of the shoulders of Ruapehu.



RUAPEHU AND TONGARIRO, FROM THE ONETAPU DESERT, ON THE SOUTH-EAST SIDE AT THE SOURCES OF THE RANGITIKEI RIVER

THE BRITISH ASSOCIATION

SECTIONAL PROCEEDINGS

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE

The Radcliffe Observer (Rev. R. Main) communicated the *Observations of Shooting Stars made at the Observatory during the past year*, from 1869, August 19, to 1870, August 31.

Since the last report to the British Association, nearly 300 shooting stars have been observed by Mr. Luces at the Radcliffe Observatory, Oxford, distributed as follows:—

27 in the remaining part of August, 1869.
11 on the 1st and 3rd of September.
17 in the month of October.
16 on the 4th and 6th of November.
21 on the nights of the 8th, 9th, and 10th.
None on the 11th in a watch at intervals from $7^h\ 30^m$ till $12^h\ 30^m$.

The nights of the 12th and 13th were thickly overcast. On the 14th there was a break from 11^h to 12^h, but no meteors seen; eight were observed on the night of the 15th, between 8^h and $13^h\ 30^m$, in bright moonlight. On the 28th one was seen.

On December 29 a remarkable meteor, about equal to one-fourth of the full moon, was seen through the window of the sitting-room, with a bright gas-light nearly between the observer and the window. Course from the Pleiades to the south horizon.

None were observed in 1870 till March 30, when one was observed by Mr. Main at $8^h\ 20^m$, larger than Jupiter, of a brilliant white, and a period of about 5 seconds from the zenith, vertically downwards a little to the south of the prime vertical.

On April 12th, at $11^h\ 13^m$, one larger than α Lyræ, of a brilliant white, visible 2^s to 3^s from a point near α Lyræ, northward about 10°.

April 19 at 14^h, 3 in quick succession were seen near α Herculis, of about second magnitude, with a rapid downward motion, one nearly vertical, one slightly inclined to the west, and the other to the east. Watch in bright moonlight till $16^h\ 30^m$.

Only 7 were seen in May, and 1 in June. On July 8, at $9^h\ 20^m$, the sky completely overcast and no star visible, a meteor was seen below the clouds at a point near Cassiopeia, with a downward motion of about 6°, and bursting at the end of two seconds of time.

Another meteor was seen below the clouds for about half a second on July 15, at $12^h\ 25^m$, near β Andromedæ, scarcely any stars being visible in that part of the heavens.

About 20 were seen on the night of July 21 by different persons while Mr. Luces was conversing with them, between 9^h and 13^h, but he did not see any till $13^h\ 43^m$, when one equal to α Lyræ left a point near that star, taking its course, with a long train, towards the north horizon.

Only 5 were seen between this and August 8, when 4 were seen in strong moonlight and clouded sky. 11 were observed on August 9 under the same circumstances; one at $13^h\ 46^m$, equal to Capella, started from δ Ursæ Majoris with a downward course, of about one second, when it burst, leaving a train visible about two seconds.

On August 10, between $9^h\ 33^m$ and $15^h\ 30^m$, 36 were observed, nearly all in the northern part of the heavens, with strong moonlight and clouded sky. One at $14^h\ 10^m$, equal to α Lyræ, of a bright white colour, burst near β Cygni.

Twenty-six were observed on August 11, between 9^h and 15^h, and on the 12th, 7 between 8^h and $10^h\ 30^m$, the sky becoming overcast at 11^h.

3 were observed on the 13th, from 10^h to 12^h.
3 on the 15th, from 12^h to 13^h.
7 on the 17th, between $9^h\ 20^m$ and 12^h.
5 on the 22nd, between $10^h\ 20^m$ and 12^h.

Four on the 24th, 3 on the 26th, 2 on the 29th and 30th, and 3 on the 31st.

The most noteworthy besides those already mentioned were :—

One on August 19, 1869, in strong moonlight, when few stars were visible, from a point near α Pegasi to near γ Pegasi, about equal to α Lyræ, for about two seconds.

On October 6, at $7^h\ 5^m$, one about equal to Jupiter appeared to burst near the S.W. horizon.

On October 27, one as bright as Jupiter, visible for two or three seconds, from ψ Tauri to the Pleiades.

November 4, at $6^h\ 5^m$, 1 equal to one-sixth of full moon, yellowish, was seen by Mr. Béchaux for about three seconds, with a train about 2° in length, from α Arietis to a point above ϵ Pegasi.

November 8, at $7^h\ 43^m$, one of the 1st magnitude, yellow, visible about 3^s, with a train from δ Aurigæ to α Draconis, and another at $8^h\ 10^m$ of the 1st magnitude, white, with a train from α Cygni to θ Lyræ, visible for three seconds.

Section B.—Chemical Science

On the Lancashire Alkali Trade.—Mr. William Gossage. This paper chiefly dealt with the scientific and commercial progress of the alkali manufacture in Lancashire during the last nine years. Mr. Gossage regarded as one of the most important facts of the last nine years the passing of the Alkali Act, 1863, an Act which makes it imperative that all manufacturers decomposing common salt for the production of sulphate of soda should condense not less than 95 per cent. of the hydrochloric acid gas evolved by such decomposition; and he said that the means which he devised in the year 1836 for effecting this condensation were now universally adopted by the soda manufacturers, with such success that not only did they comply with the legislative requirements of condensing 95 per cent. of the hydrochloric acid set free, but in many instances the condensation exceeded 99 per cent. Speaking of the benefits arising from the appointment of Dr. Angus Smith to the office of chief inspector under that Act, he considered that it may be fairly expected that when the same amount of care and attention is applied to subduing the bad effects resulting from other noxious vapours, chemical manufactories will be relieved from the charge of occasioning injury to the neighbourhoods in which they are situated. The most important use of hydrochloric acid obtained by this condensation was the manufacture of bleaching powder. At the date of his former paper, the chlorine required for the manufacture of bleaching powder was obtained by the action of hydrochloric acid on native peroxide of manganese; but recently, Mr. Walter Weldon had perfected a process whereby peroxide of manganese is obtained from the chloride of manganese produced by the action of hydrochloric acid on peroxide of manganese. Mr. Weldon's process has been successfully adopted by some of the largest manufacturers of bleaching powder. Mr. Gossage next referred to Mr. Deacon's method of manufacturing chlorine without the use of manganese, and to the circumstance that Mr. James Hargreaves, of Widnes, has also devised means for producing chlorine without the use of oxide of manganese. In his last paper, Mr. Gossage remarked that nearly all the sulphur used in the soda manufacture was re-obtained in combination with calcium, forming what is designated "alkali waste," and he then suggested that this presented a problem worthy of consideration by his juniors. Mr. Ludwig Mond, a German chemist, had now made the nearest approximation to the solution of this problem, with which he (Mr. Gossage) was at present acquainted. Mr. Mond's process had been carried out successfully by various manufacturers, but unfortunately the quantity of sulphur obtained was far short of that in the waste; and he (Mr. Gossage) considered that the problem he had mentioned still remained as an exercise for ingenuity and perseverance. He had also alluded in his paper before the Association in 1861 to the means he had adopted for obtaining copper and silver from the burnt residue of copper pyrites, which had been used for yielding sulphur in the manufacture of sulphuric acid. This mode of working had now been superseded by a process devised and carried out by Mr. Henderson. After contrasting the quantities of soda and other chemicals manufactured respectively in the Lancashire and Newcastle districts in 1852 and 1869, showing the much greater proportionate increase in the former district, he closed his paper by observing that it might reasonably be concluded that Lancashire was now the largest seat of chemical manufactures in this country.

The President, by way of supplementing Mr. Gossage's remarks, said that in the ten years previous to 1861 the increase in the amount of salt decomposed was 300 per cent. The amount consumed in 1852 was 38,600 tons, and in 1861 it had risen to 135,000. Professor Roscoe proposed a vote of thanks to Mr. Gossage for his valuable paper, and said that he was the father of the alkali trade, and that he held a position second only to that of the illustrious Leblanc, the inventor of the early process of making soda. Mr. Spence seconded the proposal, and said that Mr. Gossage was almost the originator of the soda manufacture; he was certainly the originator of some of the most important processes in it.

On the Hydrogenation and Hydriodate of Cyanogen.—Mr. T. Fairley.

On the Distillation of Sulphuric Acid.—Mr. T. Fairley.

On the Time needed for the Completion of Chemical Change.—Dr. Hurter.

On Reciprocal Decomposition viewed with Reference to Time.—Dr. J. H. Gladstone, F.R.S.

On a Method for the Determination of the Amount of Sulphur in Coal Gas.—Mr. A. Vernon Harcourt, F.R.S.

On the Estimation of Sulphur in Coal Gas.—Mr. W. Marriott, F.C.S.

Notes on Thermal Equivalents—(1) *Fermentation.* (2) *Oxide of Chlorine.*—Mr. J. Dewar, F.R.S.E.

On the Discrimination of Fibres in Mixed Fabrics.—Mr. J. Spiller, F.C.S. The author refers to the fact that silk alone, of all the materials ordinarily used in the production of textile fabrics, is soluble in concentrated hydrochloric acid, so that this reagent may be resorted to for testing the purity of silk, and determining the proportion of this substance entering into the composition of a variety of mixed goods. For the purpose of identifying wool in the presence of cotton, flax, jute, &c., it is recommended to immerse the fabric or loosened fibres in a warm aqueous solution of picric acid, which dyes the wool of a bright yellow, without imparting any colour to cotton. Thus, by testing mixed fabrics successively with hydrochloric and picric acids, valuable indications are afforded regarding their constitution. The chemical properties of certain compounds formed in this manner from silk were described, and a photographic application pointed out which turns to account the extraordinary degree of sensitiveness to light exhibited by a modified form of argentic chloride produced by precipitation from such hydrochloric solutions.

The Chemical Section did not sit on Saturday, but a large party of the members, headed by Professor Roscoe, Mr. C. W. Siemen, F.R.S., and Mr. A. E. Fletcher, F.C.S., Alkali Act Inspector, spent the day in visiting various chemical works at St. Helens.

Section C.—Geology

Report on Hæmatite.—Professor Stokes.

On the Green Slates and Porphyries of the Lake District.—Professor Harkness and Dr. Nicholson. The authors pointed out that in the Lake Country there is most commonly the three-fold series of rocks, occurring between the Skiddaw slates, upon which the green slates and porphyries rest, and the Coniston limestone which succeeds them. This series consists of traps, which form the lowest member of the group, and which are very persistent; of ashes, trappian breccias, tuffs, and amygdaloids, which constitute the middle portion of the series, and of hornstone traps, which form the highest portion of the group. The middle and upper portion of the series are by no means so persistent in their mineral characters as the lower member. The upper member was shown to be absent from the series in the Long Sleddale Valley, its place being represented by ashes and trappian breccias, and the middle series, which is usually composed of slaty ashes, breccias, and traps, was shown to be greatly modified in type in the northern portions of the Lake Country. This middle member of the series is well seen in the country south of Keswick in Borrowdale, having its normal mineral character more abounding in ashy beds, here worked for slates. Eastwards from this the slaty ashes become less abundant, and in the districts north of Ulleswater these ashes were almost entirely absent. In the Vale of St. John, porphyry, with comparatively small felspar crystals, makes its appearance in connection with the ashy slates. North-east from the Vale of St. John this porphyry becomes more developed, and the ashes are less abundant. At Eycott Hill, near Troutbeck station, the lower porphyry also occurs very finely exhibited, and containing large crystals of felspar. Near the south-east of Carrickfell, a hill largely composed of syenite rocks is seen, having a highly crystalline character, and exhibiting all the features of Diorite. These rocks the authors regard as highly metamorphic conditions of the porphyry above referred to or resulting from the action of the syenite of Carrickfell. The Caldbeck fells, which form the northern limits of the Lake district, have on their northern side the representatives of the green slates and porphyries well developed. Here there is an entire absence of the ashy slates of the middle series, the place of these being occupied by a porphyry similar to that of Eycott Hill. This porphyry, however, in the neighbourhood of Roughtongill has been so far influenced by the syenite of Carrick, veins of which penetrate it, that it now assumes a crystalline form, and appears as hypersthene rock.

The average thickness of the green slates and porphyries, or their representatives, in the Lake Country, the authors think does not exceed 5,000 or 6,000 feet, a thickness made up of igneous products, which in the north of England represent the upper Llandeillo series, and a large portion of the Caradoc or Bala group.

The authors regard the terms green slates and porphyries as applied to these rocks in Cumberland and Westmoreland, as inappropriate, since they express merely local conditions, and they propose as a substitute the name Borrowdale series.

On the discovery of Upper Silurian Strata in Roxburgh and Dumfries.—Mr. C. Lapworth. South of the great axis of the lower Silurian rocks of southern Scotland, upper Silurians had been determined many years ago by Professor Harkness in the neighbourhood of Kirkcudbright. The author had further detected these beds in a very wide strip of country extending from near Lockerbie to near Hawick, a distance of forty miles, with a maximum width of eight or ten miles. Another large outlier had been detected extending from Ernton Hill to Oxnam near Jedburgh; and a further small outlier high up in the Cheviots at the head of Kale Water. The rocks in all these districts have the facies of the Kirkcudbright series, and the fossils are common to all of them. They consist of *Graptolithus colonus, Priodon, Flemingii* and *Nillsoni, Rhynconella nucula, Orthoceras tracheale*, fragments of *Pterygotus, Ceratiocaris* or *Dictyocaris*, &c.

On the Age of the Wealden.—Mr. E. W. Judd. The Wealden constitutes one great continuous formation with well-defined palæontological characters. As with the "Poikilitic" series, its beds can only be referred to the different members of our established marine classification by violent and arbitrary divisions. It must therefore stand as one of the terms of that new system of terrestrial classification which Prof. Huxley has shown must be founded. The epoch of the English Wealden commenced towards the close of the Oolitic period; it continued during the whole of the Tithonian (a great system of rocks lately discovered on the Continent), and ceased towards the end of the middle or beginning of the Upper Neocomian. The passage of the Upper Oolite into the Wealden, and that of the Wealden into the Upper Neocomian, was each of them gradual. Fresh water deposits were formed continuously, but not contemporaneously over the whole area of the Wealden, so that in the north-west we find only the lower beds represented, and in the south-east only the upper ones, while in the central portion we find the whole series complete. In the little marine band of Punfield, only twenty-one inches thick, we have the representative of a portion of the Middle Neocomian, a formation only elsewhere found in this country in the middle of the Speeton clay and in Lincolnshire. The fauna of the marine band of Punfield has very striking affinities with that of the coal-bearing strata of Eastern Spain (which are more than 1,600 feet thick), and especially with the middle portion of that series. The North German Wealden, which is quite unconnected with that of England, and is probably the product of another river, is not strictly contemporaneous with the latter, for while it appears to have commenced about the same period, its duration was considerably less, it having terminated the close of the Lower Neocomian.

On the Physical Geology of the Bone Caves of the Wye.—Rev. W. S. Symonds. The author had lately received from Sir J. Campbell fossil bones from Arthur's Cave, on the Great Doward, on the right bank of the Wye, among them the teeth of *Equus fossilis*, and a collection had been sent to Prof. Owen, and been determined by him to belong to the mammoth, rhinoceros, hyæna, reindeer, and the great fossil ox. The caves of the Wye were at a considerable height above the bed of the river. The author considered that the district had been submerged below the glacial seas, the clefts of the precipices and the mountain limestone platform being often covered with boulder clay and angular erratic stones.

On Geological Systems and Endemic Diseases.—Dr. Moffat. From continued observation during a long practice, the author has ascertained that in a carboniferous district goitre and anœmia were prevalent, while these diseases were markedly absent in the New Red Sandstone. This he attributed to the presence of iron in the one set of rocks, and its complete absence in the other.

Report of Sedimentary Deposits of River Onny.—Rev. De la Touche. The author gave an estimate of the rate of accumulation of these deposits from a series of observations.

Notes of a Recent Visit to the Great Tunnel through the Alps and of several points of Geological Interest suggested by the Conditions of the Works in the present nearly complete state.—Prof. Ansted. The operations of the tunnel involved a direct cut through a series of rocks on a line at a great depth below the surface. At the middle of the tunnel there is 5,400 feet of rock above it. Observations on physical phenomena have been made throughout the progress of the works. The temperatures at various distances and depths have been recorded. Borings 10 feet into the rock were made at intervals of 500 metres, and the temperature determined at their extremity. The last observation made in his presence was 20,342 feet from the south end of the tunnel, and 5,000 feet from the surface. The temperature shown was 80·5° F., exhibiting an increment of 1° F. to about 100 feet. Before the value of these observations could be ascertained, the mean annual surface temperature and the depth of the permanent temperature lines must be determined. On the 31st of last month (August) there remained 2,000 out of 40,000 feet of rock to pierce; as the operations progress at the rate of 500 feet per month, the tunnel may be expected to be completed by the end of the year.

On some Points in the Geology of Strath, Isle of Skye.—Profs. King and Rowney. The authors entered into a minute description of the rock structure of the district, from which he drew the following conclusions:—That the ophite of Skye is an altered rock of the Liassic period; that it possesses the same microscopic features as the ophites of earlier geological ages, occurring in Canada, Connemara, and elsewhere; and that igneous action, developing a granitic rock, and producing decided metamorphism in an adjacent deposit, has operated at a later geological period in Skye than in any other part of the British Islands. The authors further maintained that all the features of the so-called organism, *Eozoon canadense*, had been detected by him in the Skye ophites, and asserted that the different structures known as chamber casts, canal system, nummuline layer, &c., were chemical and structural changes, induced by metamorphic action.

SECTION D.—BIOLOGY

On a mode of Reproduction by Spontaneous Fission in the Hydroida.—Prof. Allman, F.R.S. The hydroid in which the phenomenon which formed the subject of this communication had been observed is a campanularian, which in the general form of its trophosome comes near to *Obelia dichotoma*. Since however no gonosome was present in any of the specimens collected, it was impossible to assign to it a systematic position otherwise than provisionally. The remarkable physiological act by which it is distinguished, associated as this is with an important morphological character, would seem to indicate a distinct generic rank, and the author accordingly suggests for it the provisional generic name of *Schizocladium*.

Besides the branchlets, which—as in the hydroids generally—support the hydranths (plypites), others are developed in abundance from all parts of the hydrocaulus. These commence just like the ordinary branchlets, as offshoots from the hydrocaulus, and consist as usual of a continuation of the cœnosarc, invested by a chitinous perisarc. Unlike the ordinary branchlets, however, they never carry a hydranth, but are destined for the multiplication of the colony, by a process of spontaneous fission.

After the entire branchlet has attained some length, the contained cœnosarc continues to elongate itself. In doing so it ruptures the delicate pellicle of chitine which closes the extremity of the branchlet, and extends itself quite naked into the surrounding water.

It is now that the process of fission commences. A constriction takes place in the cœnosarc at some distance below its free extremity, and in the part still covered by the chitinous perisarc. The constriction rapidly deepens, and ultimately cuts off a piece which slips entirely out of the perisarcal tube and becomes a free zooid, while the surface of disseveration soon heals over, and the axial cavity of the free frustule becomes here as completely closed as at the opposite end.

The detached fragment strikingly resembles a *planula* in all points except in the total absence of vibratile cilia. It attaches itself by a mucous excretion from its surface to the walls of the vessel, and exhibits slight and very sluggish changes of form.

The further history of the fission-frustule was traced, and the important and unexpected fact was shown that it never directly develops a hydranth. After a time a bud springs from its side, and it is from this bud alone that the first hydranth of the new colony is developed.

The bud which thus becomes developed into the primordial hydranth remains attached to the fission-frustule which forms for it a sort of hydrorhiza, but which would seem ultimately to perish and give place to true hydrorhizal filaments. In the meantime the primary bud emits others, and a complex branching colony is the result.

The author compared the fission-frustule to the free medusoid element of other hydroids with which it agreed in never becoming directly developed into a new trophosome, but from which it differed in the very important fact of taking no part in the true generation of the hydroid and in giving origin to a new colony only by a simple non-sexual multiplication.

Observations on Protandry and Protogyny in British Plants.—Alfred W. Bennett, F.L.S. The arrangement of the reproductive organs in hermaphrodite plants, the presence in the same flower of both pistil and stamens, suggested to the minds of the older botanists no other idea than that of fertilisation. It is, however, now generally admitted that, even in hermaphrodite flowers, cross-fertilisation is the rule, self-fertilisation the exception. Two sets of facts have been especially observed,—in particular by Darwin in this country, Hildebrand in Germany, and Delpino in Italy,—to favour cross-fertilisation in hermaphrodite flowers; the phenomena of dimorphism and trimorphism, and the special arrangements which render it easier for the pollen to be brushed off by insects visiting the flower than to fall on its own stigma. But, besides these, another arrangement exists by which self-fertilisation is hindered, the simple fact that the stamens and pistil belonging to the same flower are frequently not ripe, so to speak, at the same time. The terms *Protandry* and *Protogyny* used by Hildebrand to express, in the one case the development of the stamens before the pistils, in the other case the development of the pistil before the stamens, are so convenient and expressive that they have been adopted in this paper; the term by which he expresses that the two organs are matured simultaneously, "Non-dichogamy," does not seem so happy, and the author proposes to substitute for it *Synacmy*—the phenomena of *Protandry* and *Protogyny* forming together that of *Heteracmy*.

The most frequent arrangement appears to be that the pollen commences to be discharged from the anthers at a longer or shorter interval before the maturing of the stigma. In some cases there still remains a certain quantity of pollen in the anthers when the stigma is ready to receive it; in other cases, the anthers have either withered up or entirely dropped off before fertilisation of the ovules can possibly take place. Synacmy, or the contemporaneous maturing of the reproductive organs, is nearly as frequent as protandry; while protogyny is a phenomenon of far less common occurrence. The two extremes among the species observed may be stated to be *Campanula rotundifolia* and *Scrophularia aquatica*. In some Natural Orders, as *Leguminosæ* and *Labiatæ*, all the species examined, with scarcely an exception, range themselves in one or other of the three classes; while in others, as *Rosaceæ*, they are distributed over all three, and in some instances, even closely allied species of the same genus differ in this respect, as, for instance, *Potentilla* and *Ranunculus*. Careful observations might even, the author thinks, in some cases, derive from this point a useful diagnosis of difficult species.

In those Natural Orders in which the flowers are furnished with two sets of stamens of different lengths, it is most usual for the longer ones to discharge their pollen at an earlier period than the shorter ones, and they probably have different functions to perform. This is commonly the case with *Cruciferæ*, *Caryophylleæ*, *Geraniaceæ*, and *Onagrariceæ*, but not, apparently, with *Labiatæ* or *Scrophularineæ*. The same phenomenon is found in those orders where the numerous stamens are arranged in different whorls, as *Ranunculaceæ* and *Rosaceæ*. The author then gave an account of a number of observations on British wild plants.

SECTION E.—GEOGRAPHY

The Ruined Indian Cities of Central America.—Captain Carmichael. The author commenced by giving an account of the impression caused on first beholding these ruins, and showed how the question involuntarily suggested itself as to the originality of their architectural designs, and stated that a certain familiarity of trait and outline was invariably recognised; and that in his opinion, formed from personal investigation, the architecture of the Aboriginal Indians of Central America was but a diversified reproduction of that of Eastern countries. He then pointed out a number of similarities in their architecture, designs, customs, &c., to nations of the East; and showed how, as a general rule, it was very difficult to explore these ruins owing to the hostility of the existing tribes of Indians.

As regards their antiquity, he assigned to many of them an earlier foundation than that accorded to them by Stephens and Squier, and adduced some very convincing, if novel, proofs in support of his theory. The picture he drew of the palaces of Quiché in Guatemala fully bore out the statement of Torquemada that they rivalled those of Montezuma; and he showed that if that city—one of some eight hundred years' standing—was in such a perfect state of conservation some fifty years ago, that the padre of a neighbouring Indian village who then walked among its streets and palaces, imagined himself in Spain, what must be the era of those numerous cities compared with which Quiché was modern?

He then pointed out the great length of these ruined cities, and added that in connection with this a remarkable fact had seemingly been overlooked by most Central American writers, viz., that the stone buildings whose ruins we now find extant were used as temples, palaces, and public offices generally, the poorer inhabitants living in huts of a perishable nature; an arrangement which represented an almost incredible amount of population. He then analysed the various elements composing the architecture of the ruined buildings and monuments, and gave an interesting account of the various uses to which the teocali and tumuli were put by the Toltecan and Aztec priests, viz., for sacrificial and burial purposes, to serve as beacons, for warlike defences, &c.; and explained the relations between the temples and alcazars or palaces, and offered a few hints as to the deciphering of the hieroglyphics, a subject to which he has paid much attention, and for which he is specially qualified from his knowledge of the Maya or Indian language, showing that they were chiefly the works of the Indian priesthood; and, above all, were intended to inculcate moral and religious precepts, chronological events being made quite subservient to them. He then referred briefly to the round towers which contained the estufas for the sacred fire of Montezuma, in connection with the worship of the Sun, and passed on to explain the nature and significance of the various hideous and awe-inspiring idols to whom the human sacrifice was offered on the summit of the teocali, and stated it as his belief that these idols, as well as the planed stones, were carved with clay or flint instruments, as he had often found flint and obsidian implements, but in no instance an instrument of metal.

Referring to the state of decay in which they were mostly found, he stated that there were ruins which had never been visited by the Spaniards at the time of the conquest, and expressed it as his opinion that their crumbling and ruinous condition was mainly brought about by the earthquakes so prevalent throughout Central America, in conjunction of course with the action on them of time and the elements. He gave a most interesting account of a ruined city in British Honduras, called Xmul, which he claims to have discovered, and concluded by pointing out the great extent of unknown and untravelled districts in Central America, particularly in Guatemala, as presenting a fine field for future geographers and naturalists, and expressed it as his firm conviction that there existed at the present day an Indian city — yet to be discovered — whose inhabitants occupy the same splendid palaces and temples as in the days of the Spanish Conquest, whose priests inscribe fresh precepts on their tablets, and who would then read to us their now mystical hieroglyphics. He supported the statement by describing an exploration he made in the southern district of British Honduras westwards towards Guatemala, where, after several days' perilous river navigation and further journey on foot, he discovered in the neighbourhood of the Coxcomb Peak the remains of an abandoned maize plantation, and saw smoke ascending from the distant forest; and believes that the tribe of Indians who occupy this part of the country, which was before considered to be uninhabited, have some connection with the mysterious Aztec city he spoke of.

Mr. H. Howorth corroborated the date of the foundation of the city of Quiché, as verified by a Mr. Spencer, who had also read a hieroglyphic on the lintel of a doorway at Palenqué. Mr. Spencer had also discovered great similarity between the names of the signs of the zodiac and the arrangement of the calendar of the Aztecs and those in use in Thibet. Several members present took part in a discussion, to which Captain Carmichael replied, adding that he had recently returned from California, where he had heard a Japanese and a digger Indian of Nevada, then brought together for the first time, converse intelligibly.

SECTION G.—MECHANICAL SCIENCE

On the Sewage of Liverpool and Neighbourhood.—Mr. J. N. Shoolbred, C.E. In this paper the author said it was calculated that about 900,000*l.* had been expended in drainage and sewage works in the borough of Liverpool. Of this about 600,000*l.* might be set down as requisite for drainage (the primary object); 300,000*l.* would, therefore, represent the amount due to conveyance of water-closet sewage; and setting aside 20 per cent. upon this as interest, together with a large amount for depreciation and repairs, &c., there would be 60,000*l.*, or about 2*s.* 4*d.* per head, as the annual expense due to the removal of the water-closet sewage. Taking the length of sewerage over the whole of the borough of Liverpool, the probable average distance that the sewage has to travel from its entrance into the sewer till its discharge into the river Mersey is about one mile and a half, or perhaps even more, inasmuch as the inhabited portions of the town mainly lie back away from the river. Liverpool and its neighbourhood are favoured by nature with above the average amount of facilities; first, for the collection of its sewage by water carriage, and then in finding, at a comparatively short distance, an outlet in the river Mersey for the larger portion which it is deemed advisable to get rid of in this manner. Again, Liverpool is fortunate in having an outlet which, at least for the present, secures immunity to the town from the unpleasant consequences which sometimes arise from creating an acknowledged sewage nuisance; while, should the town itself at any time prefer to derive some benefit out of this refuse which it now throws away, Liverpool possesses, at no great distance, a most suitable and extensive site for utilising its sewage by irrigation upon the land, with at the same time a certain market in itself for the vegetable produce of that irrigation. The author then detailed the arrangements made in 1866 and since, or in progress, for the concession of the Liverpool sewage to companies whose object is to use it in irrigation upon sewage farms; and he also described the nature of the lands which are, or may be, used for sewage irrigation.

On Sewers in Running Sand.—Messrs. Reade and Goodison, Civil Engineers. This paper formed a very natural sequel to the preceding one, inasmuch as it dealt with the difficulties of constructing sewers in the sands between Liverpool and Southport, the district traversed by the Liverpool, Crosby, and Southport Railway, and the means which the authors had adopted in order to overcome those difficulties. The whole of the district referred to is one mass of sand, resting on a bed of moss and marl, varying from ten to twenty feet deep below the surface. It has no natural drainage, and in wet seasons in the lower portions or slacks, flushes of water form, in consequence of the elevation of the shore line of sand-hills. After enumerating the manifold difficulties which they had to encounter, the authors described at considerable length the appliances which they ultimately resolved upon using. The primary object which they wished to attain was to get a dry subsoil wherein to lay the pipes, that the cement joints might have time to set and become water-tight, and by securing more time for the laying of the pipes, laying a greater length at a time, and the prevention of disturbance or drawing of the pipes while preparing the next excavations, to ensure greater certainty and perfection in the gradients and junctions, and consequently improve the general system of pipe sewerage. From the experiments which they have made with the subsoil drains, they have thoroughly satisfied themselves as to their efficiency. The subsoil drains are in fact a foundation for the pipes of the sewer, and the sewer itself can be as readily constructed upon them as if the ground were perfectly dry. They have begun to use the subsoil drains in the sewerage works which they are carrying out at Birkdale, a length of 10,000 yards.

On the Ashpit System of Manchester.—Alderman Rumney. The authorities of Manchester have at all times objected to the general use of water-closets in cottage dwellings. In the first place, because they believed that in the limited space available in houses occupied by the working classes, they would prove a greater nuisance than the privy and ashpit outside; secondly, because of the loss of valuable manure which would be occasioned; and thirdly, because, looking at the rapid increase of population in the district, and the limited area of the watershed, the time would come when all the water available would be required for domestic and manufacturing purposes, and could not be wasted in water-closets. Adhering, then, to the dry in opposition to the wet system, the corporation has for some time been engaged in the attempt to improve the existing privies and ashpits, and to discover the best form to be adapted in all new property erected within the city. In the construction of ashpits, the object of the Health Committee appointed by the corporation was to prevent as far as possible the decomposition of the excreta, and consequent generation of gases passing off into the surrounding atmosphere; and as decomposition is accelerated by moisture, they determined that all ashpits should be made dry, excluding the rainfall by covering them over, and the drainage from the yard by requiring the floors and walls to be made water-tight; they required also that the ashes from the pit should be placed daily in the ashpit for the purpose of condensing as far as possible the ammoniacal and other gases, and preventing organic matter impregnating the air in the immediate vicinity. In addition to these arrangements, it was foreseen that in summer time, when decomposition is most vigorous, and the supply of neutralising ashes most scanty, a closed ashpit might become a greater nuisance than an open one, and a ventilating shaft or chimney was determined upon, to be carried from the top of the ashpit up to the side of, and a little above, the eaves of the house, for the purpose of carrying off all the gases and light vapours, and allowing them to mix with the surrounding atmosphere at an elevation which would not injuriously affect the inmates of the dwelling. In the Appendix to the Report of the Medical Officer of the Privy Council just printed, Dr. Buchanan and Mr. Radcliffe express themselves in high terms regarding the new system. Already upwards of 1,500 new privies and ashpits have been erected under the supervision of the committee; the occupants of the houses are perfectly satisfied, and are constantly expressing their approval.

When the reading of the papers was concluded, a long and animated discussion followed, the speakers being Professor A. Reynolds, Mr. Brierly (of Blackburn), Professor Ansted, Mr. Rawlinson, C.B., C.E., Mr. Glazebrook, Mr. Hawkesley, C.E., Professor A. W. Williamson, and Mr. Hope, V.C.

The first paper in this Section on Saturday gave rise to a very unpleasant occurrence, in which the President, according to general report, adoped a rather unusual proceeding. His treatment of the author was somewhat unceremonious. The paper was entitled

On a new Heat Engine.—Mr. A. W. Bickerton, F.C.S., Associate of the Royal School of Mines. After the author had well-nigh done reading his paper, the President quite unexpectedly stopped him, and told him that he had been talking absolute nonsense. If he (the President) had seen his paper first, he would not have permitted it to be read, as there was no time to discuss a thing which was radically fallacious. The idea of an engine worked by the expansion of nitrogen under the influence of heat was fallacious in principle and practically impossible. A gentleman in the body of the room said he had listened to the paper with great interest, and regretted that it had not been allowed to be concluded. This remark was received with applause by the audience, and still greater applause followed when the author said, in retiring, that time would show whether the President or the principle was right. It seems clear that, having been accepted by the Committee of the Section, and the title of it placed upon the programme of business, the paper was entitled to be read. We are glad to lay a short abstract of the "burked" paper before our readers, expressing no opinion, further than that opinion should not be stifled.

The principle of the engine is as follows:—Crude nitrogen gas is heated in a serpentine system of tubes until the pressure is double that of the air. It is then admitted into a cylinder in which it presses forward a piston, and is allowed to expand. Next it passes into an apparatus where it is cooled, and consequently diminished to half its bulk. The cooling is effected in a new arrangement, which is so constructed that the whole of the heat above that of the external air is transferred to an equivalent volume of air passing in an opposite direction. This heated air is then used as a blast for the fire, $\frac{1}{10}$ going to the hearth of the furnace through a tuyere, and $\frac{4}{10}$ mixing with the products of combustion immediately above the fire, so as to complete any imperfect combustion, and also to modify the temperature of the whole mass, so that it may not be likely to injure the iron of the gas tubes, and the remaining $\frac{5}{10}$ being introduced into the system at a point further on. The construction of the system of tubes is such that, by the time the products of combustion reach the open air, they shall have parted with nearly all their heat, and transferred it to the nitrogen contained in the tubes, and hence a chimney draught cannot be used, and the blast has to be produced by a blowing engine. The nitrogen, after having been cooled to half the volume it occupied in the first cylinder, is then compressed and forced into the system of tubes at the point furthest from the fire. It is this forcing the gas back again into the system of heating tubes that appears absurd; but it must be remembered that the gas while leaving the heating tubes occupies twice the space it does when being forced back, hence it fills a cylinder of twice the area, and the force that may now be disposed of is equal to half the pressure exerted in the larger cylinder. But the other half of the power is not lost, it is simply conveyed back to the heating tube, and is used again. The only losses that can arise are those which are incidental to all engines, such as radiation, conduction, &c., inasmuch as there is avoided the enormous loss of heat that usually goes up the chimney, together with the still greater loss that is constantly being carried away by the condensed water,—an amount in itself six times as great as that converted into work in the steam-engine. The inventor considers that he does not expect too much if he expects his new heat engine to convert 60 per cent. of the heat of combustion into work, a duty that is fully 500 per cent. above that of well-constructed steam-engines.

Of course, as the author was not permitted to finish the reading of his paper, no discussion was taken upon it.

REPORTS OF COMMITTEES

THIRD REPORT OF UNDERGROUND TEMPERATURE COMMITTEE

Mr. G. J. Symons, whose observations, extending to a depth of 1,100 feet in a well at Kentish Town, were reported at last meeting, has since repeated his observations at several depths.

The first 210 feet of the well (which is eight feet in diameter to the depth of 540 feet) are occupied by air, and in this portion of the well the second series of observations give temperatures exceeding those observed in the first series by from 2° to 5°, the excess diminishing as the depth increases. The second series were taken in July and August, whereas the first series were taken in January. It is evident that, in this portion of the well, in spite of the precautions taken to exclude atmospheric influences, by boarding over the well and erecting a hut over it, the temperature varies with the seasons, the variations being in the same direction as in the external air, but smaller, and diminishing as the depth increases, but still amounting to 2°·2 at the depth of 200 feet.

We can feel no certainty that even the mean annual temperature in this portion of the well represents the temperature in the solid ground. On the contrary, the mean temperature in the well at any depth is probably intermediate between the temperature of the solid ground at that depth and the mean temperature of the external air.

It is well that such observations should have been carefully made and recorded in this one instance, if only for the sake of warning; and they show that we cannot expect to attain the object for which the committee has been appointed by observations in large shafts filled with air.

Mr. Symons has also repeated the observations at 250 feet (which is 40 feet under water), and at the depths of 600 feet, 750 feet, and every fiftieth foot from this to 1,100 feet, which is the lowest point attainable on account of the mud, which extends 300 feet lower. The differences from the results obtained last year are +·2, −·3, −·4, −·2, −·2, 0, −·1, −·1, 0; which, upon the whole, strongly confirm the correctness of the observations.

The temperature at 1,100 feet is 69°·8, which, if we assume the mean temperature of the surface of the ground to be $\left\{\begin{matrix}50^\circ\\49^\circ\end{matrix}\right\}$, gives a mean increase downwards of $\left\{\begin{matrix}\cdot0180\\\cdot0189\end{matrix}\right\}$ of a degree Fahrenheit per foot, or 1° for $\left\{\begin{matrix}55\cdot5\\52\cdot9\end{matrix}\right\}$ feet.

The curve in which temperature is the ordinate and depth the abscissa, exhibits considerable irregularities till we reach the depth of 650 feet, beyond which it is nearly a straight line, and represents an increase of ·0187 of a degree per foot.

The strata penetrated by the well to the depth to which our observations extend, consist of clay, sand, chalk, and marl, besides flints. (See tabular list appended.)

Mr. Symons, in his report, calls attention to the anomalous position of a column of water, increasing in temperature and, consequently, diminishing in specific gravity downwards, and suggests the inquiry why the warmer and lighter portions do not ascend to the top. The proper reply seems to be that the diminution of specific gravity, amounting to less than one part in 50,000 per vertical foot, does not furnish sufficient force to overcome liquid adhesion, and the water is thus able to remain in unstable equilibrium.

Mr. Symons intends during the remainder of the present year, verifying those of his observations which have not yet been repeated, and concludes his report by remarking that it appears desirable to ascertain by observations from year to year, whether the temperature at a given depth (say 1,000 feet) remains constant or is subject to minute changes, periodical or otherwise—a suggestion which appears fully worthy of being carried out.

Mr. Wm. Bryham, manager of Rosebridge Colliery, Ince, near Wigan, has taken very valuable observations during the sinking of that colliery, which is now the deepest excavation in Great Britain. The principal results have already been given in a paper to the Royal Society by Mr. Edward Hull, director of the Geological Survey of Ireland, who had previously published some important contributions to our knowledge of underground temperature, and has now consented to become a member of this committee. Some of the depths have however been remeasured since Mr. Hull's paper was read, and we are now enabled, through the kindness of Mr. Bryham, to furnish a rather more accurate report.

The temperatures observed, and the depths at which they were taken, are as follows:—

Depth in Yards.	Temperature Fahrenheit.
161	(64½)
200	(66)
558	78
605	80
630	83
663	85
671	86
679	87
734	88½
745	89
761	90½
775	91½
783	92
800	93
806	93½
815	94

All these temperatures, except the two first, were observed during the sinking of the shaft, by drilling a hole with water, to the depth of a yard, in the solid strata at the bottom. A